The Third Burst and Transient Source Experiment Catalog of Gamma-Ray Bursts

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205–544–7694

The Burst and Transient Source Experiment, developed and managed at MSFC, is one of four gamma-ray instruments in the Compton Gamma-Ray Observatory, which was launched in April 1991. The primary objective of the experiment is to gather information on gamma-ray bursts—brief, intense flashes of gamma radiation—from unknown celestial sources. The experiment instrument remains the most sensitive tool ever deployed for studying these events.

Early program results[1] showed that the bursts observed were uniformly distributed in angular position on the sky, but that there were far fewer faint bursts than would be expected if the sources were uniformly distributed in space. No known celestial objects in our galaxy have such a spatial distribution, leading most researchers to the conclusion that the burst sources must be in distant galaxies. (See the following article for implications of this hypothesis.) If this turns out to be the case, then gamma-ray bursts must be the most luminous events in the Universe. Others believe that an extended halo of sources around our own galaxy can fit the data, with much lower energy requirements. The nature of gamma-ray bursts is currently hotly debated, but poorly understood.

The experiment team has recently completed a catalog of 1,123 gamma-ray bursts observed up to September 19, 1994. The catalog (referred to as the "3B" catalog) is the largest catalog of its kind, improves upon two previous releases of experimental data, and is now publicly available from the Compton Observatory Science Support Center at Goddard Space Flight Center. The World-Wide Web address is http://cossc.gsfc.nasa.gov/cossc/cossc.html. These data will be studied by astrophysicists around the world for clues to the origin of gamma-ray bursts.

A major effort in generating the 3B catalog has been directed toward improving the accuracy of the angular positions. Previously, the systematic errors in locations were about 4 degrees. Improvements in the location algorithm have now reduced this error to about 1.6 degrees. All of the previously cataloged bursts have had their locations recomputed for the 3B catalog. The accuracy of the locations is important in exploring the possibility that more than one burst may be coming from a single source. The existence of such repetitions is currently a controversial issue.

The distribution on the sky of the 1,123 bursts of the 3B catalog is shown in figure 14. The sky is shown in galactic coordinates, with the galactic plane along the equator and the galactic center in the center of the plot. Galactic objects generally show a concentration toward the equator or center. Within the statistical uncertainty, the gamma-ray bursts are distributed isotropically.

The distribution in peak intensity is shown in figure 15. The peak intensity is the peak photon flux in a 1,024-millisecond interval as measured at the detector. In general, the peak intensity distribution is a convolution of the

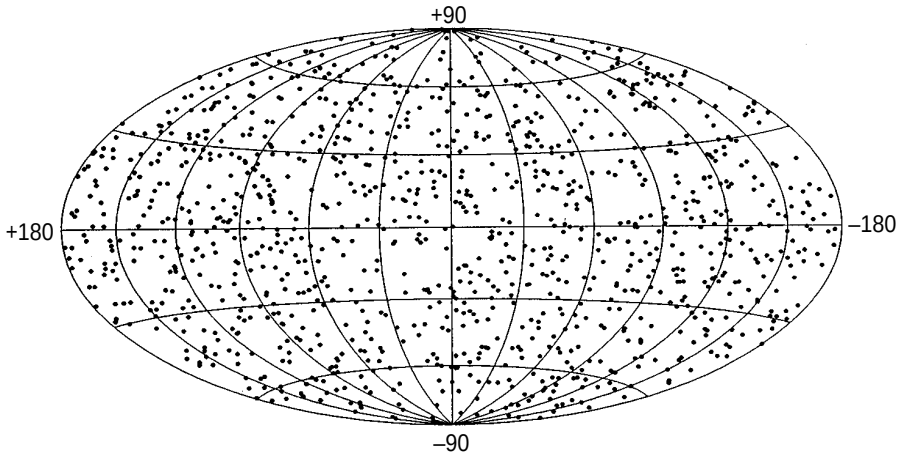

FIGURE 14.—The locations, in galactic coordinates, of 1,123 gamma-ray bursts in the 3B catalog. The bursts are isotropic to within the statistical uncertainty.

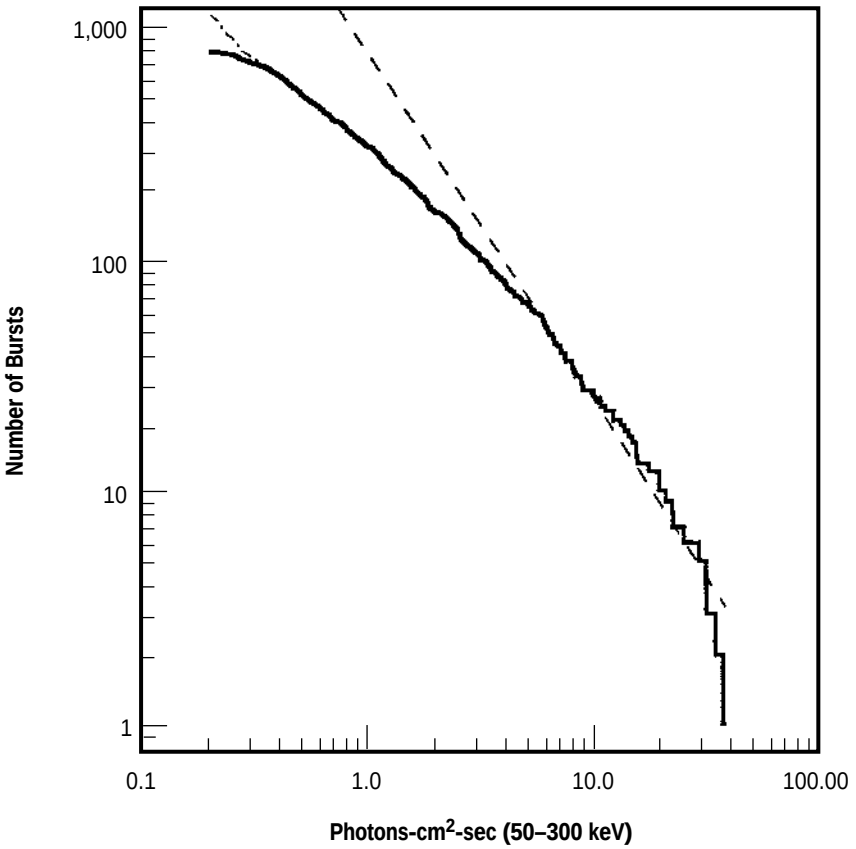

FIGURE 15.—The intensity distribution of gamma-ray bursts. The dashed line is the –3/2 power law expected for a spatially uniform distribution of sources.

intrinsic luminosity distribution with the distribution in distance. However, if the sources are uniformly distributed in space, then the brightness distribution will follow a –3/2 power law for any luminosity distribution. The data clearly show a deviation from the –3/2 power law (the dashed line in fig. 15). A number of studies have shown that the shape of this distribution is consistent with the sources being at cosmological distances where red-shift effects cause the deviation from the –3/2 curve.

The location and brightness distributions provide the most direct evidence on the spatial distribution of gamma-ray burst sources. The third Burst and Transient Source Experiment Catalog of gamma-ray bursts will be crucial in finally understanding these enigmatic events.

[1]Meegan et al., 1992. *Nature*, 355:143–5.

Sponsor: Office of Space Science